



## WISSENSCHAFTLICHE KURZMITTEILUNGEN

### **Chromosomal conservatism in southern African Klipspringer antelope (*Oreotragus oreotragus*): a habitat specialist with disjunct distribution.**

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Klipspringer are small antelope, standing approximately 60 cm at the shoulder, which inhabit mountainous, rocky habitats to which they are closely confined (SMITHERS 1983). Although widely distributed from the Western Cape Province of South Africa through to east Africa (Fig. 1), their occurrence within this range is patchy and discontinuous. This disjunct distribution raises the possibility that the reported phenotypic differences between the 11 recognized subspecies (ANSELL 1972 but see GRUBB 1993) reflect underlying genetic partitioning promoted, in part, by limited gene flow between demes. Should these genetic differences extend to fixed chromosomal rearrangements between geographically defined populations, the translocation of this antelope from one area to another as part of game ranching practices, and ecotourism considerations, could have significant long-term conservation implications for the species.

We have argued elsewhere (ROBINSON and ELDER 1993) that matings between specimens characterized by different cytotypes can result in perinatal mortality or, at a later stage, in reduced fertility of offspring heterozygous for chromosomal rearrangements. The current investigation was prompted by concerns relating to the relocation of klipspringer from the northern reaches of South Africa into suitable habitat in the extreme southwestern portion of the Western Cape Province, and the fear that the translocation could negatively impact on the viability of resident populations in the area. Our aim was therefore to ascertain whether geographically discrete populations of the klipspringer differed detectably in chromosome structure. In so doing, we would provide wildlife managers with genetic guidelines (albeit only at the level of gross genetic incompatibility) for the development of a translocation policy for this species within southern Africa. Additionally, as far as we have been able to ascertain, these cytogenetic data are the first recorded for *O. oreotragus*, an endemic African antelope of the subfamily Neotraginae.

Ear clippings were taken in the field from adult klipspringer specimens, transported to the laboratory, and used to establish fibroblast cell cultures following routine procedures. The country of origin, collection localities and number of specimens analyzed are: Zimbabwe: Bulawayo (20°07' S 28°35' E); one male and one female; South Africa: Grabouw (34°09' S 19°01' E); one male; Kruger National Park (23°50' S 31°30' E); one male and one female.

Air-dried slides were G-banded using ENZAR-T trypsin (Interger Cat. number 7000-65) and C-banded using a barium hydroxide 2×SSC treatment (SUMNER 1972). G-banded



**Fig. 1.** Pan-African distribution of the klipspringer, *Oreotragus oreotragus* (from SMITHERS 1983). White dots indicate approximate collection localities for specimens used in the present study.

karyotypes from each specimen were arranged and numbered according to the standard cattle GTG-banded karyotype (ISCNDA 1989). However, the contracted state of the klipspringer chromosomes, especially the smaller autosomes, confounded comparisons with the cattle standard and in some instances their placement as cattle homologs is equivocal.

The klipspringer analyzed herein, irrespective of their geographic origin, are characterized by an invariant karyotype with  $2n = 60$ ; all chromosomes, including the X and Y, are acrocentric in morphology (Fig. 2). This strict chromosomal conservatism, reflected by both G-banding and diploid number, extends also to the species' C-bands. The klipspringer constitutive heterochromatin is centromeric. No marked heteromorphisms were evi-



**Fig. 2.** Typical G-banded karyotype of the klipspringer (*Oreotragus oreotragus*).

dent within or between specimens, and no interstitial C-bands have been detected in the specimens examined. The Y chromosome appears entirely heterochromatic following C-banding, but is not as darkly staining as the pericentromeric material present in all autosomes and the X. This presumably reflects some difference in the repeated sequences comprising the heterochromatin at these sites.

The chromosome number within the family Bovidae varies from  $2n = 30$  to  $2n = 60$  but the number of chromosomal arms has remained relatively constant at 56–58 for most karyotyped bovids (GALLAGHER and WOMACK 1992). It is generally regarded that bovid chromosomal evolution has progressed from a primitive karyotype with  $2n = 60$  comprising 58 acrocentric autosomes, a configuration currently retained in representatives of many of the bovid subfamilies (WURSTER and BENIRSCHKE 1968; GALLAGHER and WOMACK 1992; GALLAGHER et al. 1994; ROBINSON and HARLEY 1995). Therefore, in spite of its propensity to population fragmentation due to habitat constraints, the klipspringer, like so



**Fig. 3.** Typical C-banded metaphase chromosomes of the klipspringer (*Oreotragus oreotragus*); inset shows the heteropycnotic nature of the Y chromosome.

many of the Bovidae, appears to have retained the ancestral autosomal condition. Of course it is not possible to isolate a single factor which may have contributed to the maintenance of this primitive state, but, clearly, it does raise the question of how efficient population subdivision and the formation of small demes in this species is. Small effective population size ( $N_e$ ) is generally considered a prerequisite for the fixation of chromosomal rearrangements (WILSON et al. 1975; BUSH et al. 1977; KING 1993). Occasional exchanges between apparently isolated populations will decrease stochastic genetic loss (caused through the effects of inbreeding) and increase the effective population size (CHESSER 1983) and may therefore act to constrain chromosomal evolution. In this respect it is noteworthy that in spite of their saxicolous habit and the accompanying extreme specialization in hoof morphology (klipspringer walk on the tips of their hooves – an adaptation to their life among rocks), there are reports documenting relatively long range movements of animals between rocky areas which are separated by unsuitable habitat (NIETHAMMER 1942; WILSON and CHILD 1965; SMITHERS 1971). Such observations suggest that the klipspringer will show weak geographic structure when assessed by other genetic markers. This prediction receives preliminary support from mitochondrial DNA data which show no meaningful differences between populations in east and southern Africa.

While our investigation removes one of the more obvious concerns governing the movement of klipspringer over large geographic distances, it must be emphasized that the apparent lack of regional cytotypes does not imply the absence of genetic differences be-



tween distant populations. Quite clearly, additional studies providing data at a finer level of resolution and a more extensive geographic representation are prerequisites for the development of successful translocation policies. Until such data become available, proposals to relocate these antelope over extensive geographic distance should be considered cautiously.

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## References

- ANSELL, W. F. H. (1972): Order Artiodactyla. In: *The mammals of Africa: an identification manual* 15: Ed. by J. MEESTER and H. W. SETZER. Washington, D. C.: Smithsonian Institution Press. Pp. 1–84.
- BUSH, G. L.; CASE, S. M.; WILSON, A. C.; PATTON, J. L. (1977): Rapid speciation and chromosomal evolution in mammals. *Proc. Nat. Acad. Sci. U.S.A.* **74**, 3942–3946.
- CHESSER, R. K. (1983): Isolation by distance: relationship to the management of genetic resources. In: *Genetics and Conservation*. Ed. by C. M. SCHONEWALD-COX, S. M. CHAMBERS, B. MACBRYDE and L. THOMAS. London: Benjamin/Cummings. Pp. 66–77.
- GALLAGHER, D. S.; WOMACK, J. E. (1992): Chromosome conservation in the Bovidae. *J. Hered.* **83**, 287–298.
- GALLAGHER, D. S.; DERR, J. N.; WOMACK, J. E. (1994): Chromosome conservation among the advanced pecorans and determination of the primitive bovid karyotype. *J. Hered.* **85**, 204–210.
- GRUBB, P. (1993): Order Artiodactyla. In: *Mammal species of the world: A taxonomic and geographic reference*. Sec. Ed. Ed. by D. E. WILSON and D. M. REEDER. Washington, D. C.: Smithsonian Institution Press. Pp. 377–414.
- ISCNDA (1990): (International System for Cytogenetic Nomenclature of Domestic Animals). The second international conference on standardization of domestic animal karyotypes, Jouy-en-Josas, France May 22–26, 1989. DiBERARDINO, D.; HAYES, H.; FRIES, R.; LONG, S.) *Cytogenet. Cell Genet.* **53**, 65–79.
- KING, M. (1993): Species evolution the role of chromosome change. Cambridge: Univ. Press.
- NIETHAMMER, G. (1942): Über den Klipspringer Deutsch-Südwest-Afrikas. *Zool. Gart. Leipzig* **14**, 139–149.
- ROBINSON, T. J.; ELDER, F. F. B. (1993): Cytogenetics: its role in wildlife management and the genetic conservation of mammals. *Biol. Conserv.* **63**, 47–51.
- ROBINSON, T. J.; HARLEY, E. H. (1995): Absence of geographic chromosomal variation in roan and sable antelope and the cytogenetics of a naturally occurring hybrid. *Cytogenet. Cell Genet.* **71**, 363–369.
- SMITHERS, R. H. N. (1971): The mammals of Botswana. *Mus. mem. Natl. Mus. Monum. Rhod.* **4**, 1–340.
- SMITHERS, R. H. N. (1983): *The Mammals of the Southern African Subregion*. Pretoria: University of Pretoria.
- SUMNER, A. T. (1972): A simple technique for demonstrating centromeric heterochromatin. *Expl. Cell. Res.* **75**, 304–306.
- WILSON, A. C.; BUSH, G. L.; CASE, S. M.; KING, M. (1975): Social structuring of mammalian populations and rate of chromosomal evolution. *Proc. Nat. Acad. Sci. U.S.A.* **72**, 5061–5065.
- WILSON, V. J.; CHILD, G. T. F. (1965): Notes on the klipspringer from tsetse fly control areas in eastern Zambia. *Arnoldia Rhod.* **1**, 1–9.
- WURSTER, D. H.; BENIRSCHKE, K. (1968): Chromosome studies in the superfamily Bovoidea. *Chromosoma* **25**, 152–171.

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